Developing Student Researchers

Ellen Babcock, Blake Phillips, Dori Lichter, Ewen Crunkhorn, Simos Vassiliou, Andrew Pregnall, Sloane Palmer, Rebecca Weller, Zach Nash, WT Woodson High School Fairfax VA
Dr. Margaret Pippin and Robert Bujosa NASA Langley Research Center, Hampton VA

To Best Serve My Students

WT Woodson High School in Fairfax VA.
Demographics:
Asian.....22.21%
Black.....3.48%
Hispanic.....9.93%
White.....60.00%

Who are my students?

- Honors physics to juniors and seniors ages 16 to 18.
- High Achieving
- Ninety-five percent go to college either four year or local Community College.
- Fierce competition for slots at the best colleges
- Highly educated parents with very high expectations

In my third year working within the LEARN program, I decided to bring my students into the process, by offering them the opportunity to work with NASA scientists. In this first year offering the research option, eight students decided to give it a try.

Working in a truly collaborative science community gave me the opportunity to show these students at least a bit of what it might be like to be a scientist; to engage in authentic research. It is one of the best things I could possibly have done for my students.

The idea was to treat the students like a research group, all working towards the same goal, but each carrying out their individual part. Working together through after school meetings and online collaboration, the students were responsible for submitting their work to me in poster form for a grade as it was completed.

When we first started this project in mid-October, we knew we would have to meet after school, as the group of students went across class periods. At the first meeting, we began to define the project, and our vision of where it would go and how it would work, and ended with a directive to study up on the basics of fracking. At the next meeting we identified several different topics of research that would have to be completed to move the project forward. The topics identified were Chemistry, Meteorology, and Geography. Once everyone had split into groups, the groups were given assignments based on what was needed to be done at the time. With this database growing, we set to work in earnest.

Because the various group members were in their junior and senior years of high school, the amount of attention given to the research was sporadic, and it was January before the completed map and recommended sites were given over to the Chemistry team. They identified a list of many of the chemical agents used in fracking and started to identify basic chemical ingredients and how they might affect the surrounding environment.
However, the team soon realized that the biochemistry that was going to be needed to recognize every possible atmospheric interaction was going to be far beyond what they could learn in the limited time that was left. A web conference was held with Dr. Pippin and Mr. Bujosa, and it was decided that the project would switch focus from the individual fracking chemicals and their possible effects, to a broader discussion on air pollution and the increase of ozone in Pennsylvania.

Work Cited

•http://ic.galegroup.com/ic/scic/topic/actionWin?resetBreadCrumb=&query=&prodId=SCIC&windowstate=normal&contentModules=&display-query=&mode=view&limiter=AC+y&showDisambiguation=&u=fair35939e&displayGroups=&p=SCIC&action=e&catId=GALE%7COWJADB227635689&scanId
•http://go.galegroup.com/ps/i.do?id=GALE%7CA352848976&v=2.1&u=fair35939e&it=r&p=GPS&sw=w&asid=c962b545572a219883c612cead2662ff
•http://setxind.com/upstream/how-hydraulic-fracking-is-used-and-the-reasons-for-it/
•http://closup.umich.edu/fracking/timeline/
•http://ecowatch.com/2014/09/08/fracking-wastewater-study/
•http://serc.carleton.edu/NAGTWorkshops/health/case_studies/hydrofracking_w.html
•http://stateimpact.npr.org/pennsylvania/drilling/ **(Fracking Map)**
•http://www.fracfocus.org/chemical-use/what-chemicals-are-used

What Did the Students Do? The Student Research Process

Background Research
- What is Fracking?
- History of Fracking
- Chemistry of Fracking

Research Plan
- Focus of research
- Components of project
- Assignment of Tasks

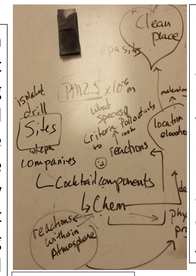
Site Selection
- Proximity to drilling
- Available EPA data

Data Retrieval and Processing
- EPA
- AirNow Tech
- Calipso Data Tools
- Excel and Igor

What is Fracking
Hydraulic fracturing is a process by which pressurized fluid increases the amount and degree of fractures in subsurface rock layers. It may be used to extract petroleum or gas trapped in source rock, such as oil shale, gas shale, coal seams. It is a two step process that involves first drilling and preparing the well and then, over the course of three to ten days, water, sand, and chemicals are injected under high pressure, into the well, fracturing the surrounding sedimentary rock and releasing trapped oil and gas.
Fracking comes in four main forms, vertical wells, which penetrate perpendicular to the rock layer and increase efficiency and output while requiring lower pressure and volume, horizontal wells, which are parallel to the rock layer with a much higher pressure and volume of chemicals, high-rate fracking, which uses a high rate of pumping to deliver the proppant, is associated with slick water fracking fluids, and causes a network of small, spread out micro fractures, and high-viscosity fracking, which uses a Higher fluid viscosity as its means of effectively delivering the proppant, causing larger, more dominant fractures.
Fracking in Pennsylvania involves 62 operating companies with 7,109 Active wells. On December 16, 1974 the Safe Drinking Water Act started putting regulations on the then barely existent Pennsylvania industry. On April 18, 2003 the first Marcellus shale well was drilled, opening up fracking as a major industry in the area. On November 9, 2005 the first horizontal drilling permits were issued in Pennsylvania

Dangers of Fracking
Methane releases from fracking are dangerously high. This phenomenon is supposed to be addressed and regulated under the Clean Construction USA and the Clean Air Act.
The potentially harmful waste products of fracking are largely liquid, including barium, chromium, copper, mercury, arsenic and antimony, which are found in the wastewater at high enough levels that they could be harmful if consumed.

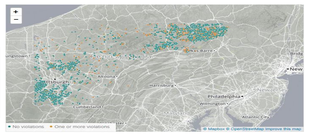
After our first WebEx with Dr. Pippin and Robert Bujosa, the Fracking Research Team developed a sketch of what would be our process: to locate "dirty" sites with many fracking wells , learn what chemicals were being pumped into the ground and so likely leaking into the atmosphere, and then look to "clean" sites for signs of contamination.



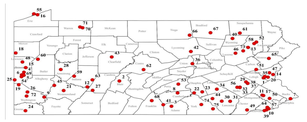
Starting Concept Map of Project

Initially, the Meteorology and Geography teams got together to decide the location of two EPA testing sites, one to act as a Control Zone, upwind of almost, if not all, fracking locations, and one as near as possible to at least one fracking site. They merged a map of EPA sites and a map of fracking sites in order to do so.
Because of this being the various group members junior and senior years of high school, the amount of attention put into this research was sporadic, and it was January before the completed map and recommended sites were given over to The Chemistry team identified many of the chemical agents used and how they might affect the surrounding environment. However, the team soon realized that the biochemistry needed to recognize every possible atmospheric interaction was going to be far beyond what they could learn in the time available. A web conference with Dr. Pippin and Mr. Bujosa decided that the project would switch focus from the individual fracking chemicals and their possible effects to a broader discussion off air pollution and the increase of ozone in "clean" areas, Johnstown, Altoona, and State College downwind from "dirty" fracking sites in Houston and Kittaning.

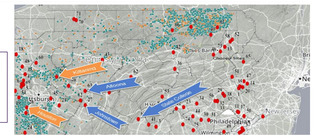
PA Fracking Sites



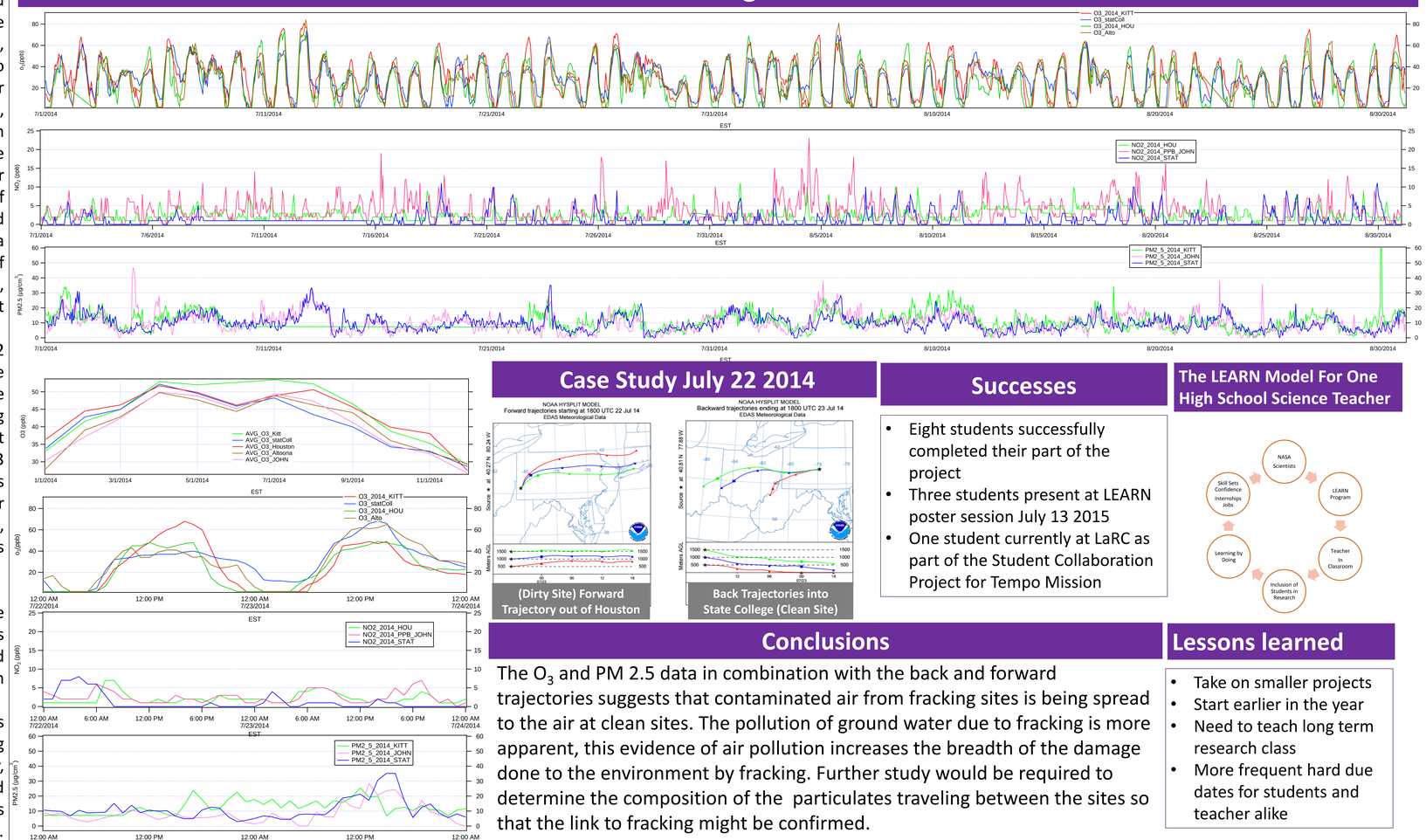
PA EPA sites



Superimposed Map with chosen sites



The Science: From Fracking Site to Clean Air Site



Case Study July 22 2014

(Dirty Site) Forward Trajectory out of Houston

Back Trajectories into State College (Clean Site)

Successes

- Eight students successfully completed their part of the project
- Three students present at LEARN poster session July 13 2015
- One student currently at LaRC as part of the Student Collaboration Project for Tempo Mission

The LEARN Model For One High School Science Teacher

Conclusions

The O_3 and PM 2.5 data in combination with the back and forward trajectories suggests that contaminated air from fracking sites is being spread to the air at clean sites. The pollution of ground water due to fracking is more apparent, this evidence of air pollution increases the breadth of the damage done to the environment by fracking. Further study would be required to determine the composition of the particulates traveling between the sites so that the link to fracking might be confirmed.

Lessons learned

- Take on smaller projects
- Start earlier in the year
- Need to teach long term research class
- More frequent hard due dates for students and teacher alike